

# Workshop on Detectors for Synchrotron Research

## Report of Working Group on Detectors for X-ray Imaging

November 24, 2000

### Working Group Members:

Mark Rivers, Chair, University of Chicago  
Michael Feser, SUNY Stony Brook  
Peter Ilinski, Argonne National Laboratory  
Bo Yu, Brookhaven National Laboratory  
J. Michael Schoonmaker, Louisiana State University

This working group considered detectors for synchrotron x-ray imaging applications. We defined imaging to include the following:

- Soft x-ray projection microscopy and tomography
- Soft x-ray scanning microscopy and tomography
- Hard x-ray radiography and tomography
- Holography
- X-ray diagnostics, such as x-ray focusing tools and particle beam size/position measurements

We specifically did not include scanning fluorescence techniques, since detectors for those applications were covered by the working group on EXAFS detectors.

For many x-ray imaging applications currently available commercial detectors, such as CCDs, fulfill the needs of many experiments. However, the best available commercial detectors are not always being used on such beamlines due to lack of funding.

**Recommendation #1:** The DOE should ensure funding for the best commercial x-ray imaging detectors for existing beamlines. The cost of such detectors is generally less than \$100,000 and is a small fraction of the cost of a beamline.

For soft x-ray full field microscopy experiments back-thinned commercial CCD detectors are currently used. The community needs detectors which are larger and faster. However, we do not believe that such developments should be pursued by DOE laboratories given the scale of the infrastructure required. Hopefully such developments will be made by commercial vendors whose primary markets are in other fields.

Soft x-ray transmission microscopy requires specialized detectors which are not commercially available. These detectors include high-speed gas proportional counters and segmented silicon detectors. Developments of such detectors have been pursued for over 10 years at Brookhaven National Laboratory. These projects are modest in scope and serve a need which will otherwise not be met.

**Recommendation #2:** The DOE should continue to fund detector developments for soft-ray detectors in scanning microscopy. Such detectors should be made available to groups at other soft x-ray scanning microscopy beamlines, for example at the ALS.

For hard-ray radiography and tomography detectors typically consist of three components:

1. A scintillator crystal to convert x-rays to visible light
2. A visible light optical system to image the scintillator onto a detector
3. A CCD detector to measure the visible light image.

Item 1 above is the major problem. The spatial resolution available with ordinary scintillator crystals is far from adequate for hard x-rays. Significant advances in synchrotron hard x-ray imaging science could be achieved if detectors with the following spatial resolutions were available

1. 1 micron at 10 keV
2. 5 microns at 45 keV
3. 10 microns at 80 keV

For tomography applications at least 14 bit dynamic range and 10 frames per second at 1024x1024 are needed. This is not yet available in commercial CCD detectors, though it is being approached.

**Recommendation #3:** The DOE should fund detector developments to improve the spatial resolution of x-ray imaging detectors at high energy. This may include research on structured scintillators and also pixel array detectors.